Serial No. 09/850,183
Reply to Office Action of September 9, 2004

Amendments to the Specification:

Please replace the paragraph [0004] with the following amended paragraph:

[0004]   A hardware repair may be relatively simple. For example, a service technician replaces the defective component. This repair action usually is successful. Software repairs, however, differ from hardware repairs. Software may be repaired by restarting some fraction of the system components, but such repair ~~attempets~~ attempts often may fail. Software restarts may be escalated by restarting more components. These higher level repairs are often more effective. Multiple levels of escalation may exist.

Please replace the paragraph [0005] with the following amended paragraph:

[0005]   A system may include a large number of distinct software components. Each component may have different failure rates and modes, and different ~~levewls~~ levels of restart may have different efficacies. The overall recovery time for a whole node is a non-trivial function of the recovery times for all of the individual software components.

Please replace the paragraph [0006] with the following amended paragraph:

[0006]   Hardware failures may be modeled hierarchically such that the results of a complex lower level model can be wrapped up into a few failure rates in a higher level model. Thus, a complex system may be viewed as a ~~rested~~ nested set of simpler models. Software tends to have cross-level interactions, and it may be necessary to include all of the software components into the higher level models. Problems may arise from this practice because the complexity of a model is exponential in the number of components that it contains.

Please replace the paragraph [0009] with the following amended paragraph:

[0009]   According to another embodiment, a method is provided for incorporating a software component into a model of a network. The method includes determining failure rates for warm recoverable errors and non-warm recoverable errors of the software component. The method also includes determining the recovery rates for warm recoverable errors and non-warm recoverable errors of the software components. The method also includes generating warm recoverable error recovery rates. The method also includes

\\\BO - 60168/0108 - 170900 v1

2

PAGE 3/18 * RCVD AT 11/10/2004 7:21:10 PM [Eastern Standard Time] * SVR:USPTO-EFXRF-1/3 * DNIS:8729306 * CSID: * DURATION (mm-ss):05-22

Serial No. 09/850,183
Reply to Office Action of September 9, 2004

generating non-warm recoverable error failure rates and the non-warm recoverable
error recovery rates.

Please replace the paragraph [0010] with the following amended paragraph:

[0010]   According to another embodiment, a network model of a network
having at least one node is disclosed. The network model includes a node model for
the node. The network model also includes node parameters for the node model.
The node parameters include a reboot time. [[the]] The network model also includes
a warm recoverable software error state for the node model. The warm ~~recoverable~~
recoverable software error state models warm recoverable software errors of
software components on the node. The network model also includes a non-warm
recoverable software error state for the node [[mode]] model. The non-warm
recoverable software state models non-warm recoverable software errors of the
software components on the node.

Please replace the paragraph [0012] with the following amended paragraph:

[0012]   According to another embodiment, a computer program product
~~comprising~~ is provided that includes a computer useable medium having computer
readable code embodied therein for incorporating a software component into a
network. The computer program product is adapted [[when]] to run on a computer to
effect the following steps. The steps include determining recovery rates for warm
recoverable errors and non-warm recoverable errors of the software component.
The steps include generating warm recoverable error state parameters from the
warm recoverable error failure rates and the warm recoverable error recovery rates.
The steps include generating non-warm recoverable error state parameters from the
non-warm recoverable error failure rates and the non-warm recoverable error
recovery rates.

Please replace the paragraph [0013] with the following amended paragraph:

[0013]   According to another embodiment, a computer program product
~~comprising~~ is provided that includes a computer useable medium having computer
readable code embodied therein for modeling a software error within a network
model. The computer program product is adapted [[when]] to run on a computer to
effect the following steps. The steps include determining a recoverable state for the
error. The steps also include determining a failure rate for the error. The steps also

\\NO - 60168/0100 - 170900 v1

3

Serial No. 09/850,183
Reply to Office Action of September 9, 2004

include determining a recovery rate for the error. The executed steps also include incorporating the failure rate and the recovery rate into the recoverable state.

Please replace the paragraph [0026] with the following amended paragraph:

[0026]   Fig. 2 depicts software component error states in accordance with an embodiment of the present invention. The different component error states depicted in Fig. 2 correlate to the different types of failures and recovery actions for a software application running on a node in network 100, such as software application 108. The software modeling components also may be used to model operating systems on nodes, such as operating system 104. Software applications, however, will be referred to in the discussion regarding Fig. 2.

Please replace the paragraph [0027] with the following amended paragraph:

[0027]   Embodiments of the present invention characterize the behavior of individual software components in a clustered computer system and incorporate their combined effects into an understandable and maintainable model without losing the different behaviors of the individual software components. Availability models may characterize failure events by their implications, and not by their causes. The disclosed embodiments adopt this approach and distinguishes four classes of failures. The four classes may capture a large share of failure behavior. The classes may be intuitive and the associated parameters may be reasonably measurable or estimatable. The parameters of [[the]] these classes may be meaningfully summable.

Please replace the paragraph [0031] with the following amended paragraph:

[0031]   The recovery rate for software component soft reset state 202 includes an error detect time and a recovery time to resolve the failure. For example, the recovery rate may be the time to detect the application failure and to soft reset the application. This rate may be known as mu-sw-csr. ~~Preferably, mu-sw-csr may be greater than or equal to about 1 Hz.~~ Software component soft reset state 202 also includes a value for the fraction of repair failures. This value would model for recovery actions that are not effective in resolving the application failure, such as misdiagnosis of the failure, a corruption in the checkpoint stored for the application, miscellaneous failures to restart and the like. The fraction of recovery failures value may be known as f-csr-fail.

4

Serial No. 09/850,183
Reply to Office Action of September 9, 2004

Please replace the paragraph [0033] with the following amended paragraph:

[0033]   The recovery rate for software component warm restart state 204 includes an error detect time and a recover time to resolve the failure. For example, the recovery rate may be the time to detect the application failure and to warm restart the application. This rate may be known as mu-sw-cwr. ~~Preferably, mu-sw-cwr may be in the range of about .3 Hz to about .6 Hz.~~ Software component warm restart state 204 also includes a value for the fraction of recovery failures. This value would model recovery actions that are not effective in resolving the application failure, such as misdiagnosis of the failure, a corruption in the checkpoint stored for the application, miscellaneous failures to restart and the like. The fraction of recovery failures value may be known as f-cwr-fail.

Please replace the paragraph [0035] with the following amended paragraph:

[0035]   The recovery rate for software component cold restart state 206 includes an error detect time and a recover time to resolve the failure. For example, the recovery rate may be the time to detect the application failure and to cold restart the application. This rate may be known as mu-sw-ccr. ~~Preferably, mu-sw-ccr may be in the range of about .3 Hz to about .6 Hz.~~ Software component cold restart state 206 also includes a value for the fraction of recovery failures. This value would serve to model recovery actions that are not effective in resolving the application failure, such as misdiagnosis of the failure, miscellaneous failures to restart and the like. The fraction of recovery failures value may be known as f-ccr-fail.

Please replace the paragraph [0037] with the following amended paragraph:

[0037]   The recovery rate for software component fail-over model 208 includes an error detect time and recover time to resolve the failure. For example, the recovery rate may be the time to detect the application failure and to reboot the node. This rate may be known as mu-sw-cfo. ~~Preferably, mu-sw-cfo may be in the range of about .3 Hz to about 1 Hz.~~ Software component fail-over state 208 also includes a value for the fraction of recovery failures. This value would serve to model recovery actions that are not effective in resolving the application failure, such as corruptions in the checkpoints, miscellaneous failures to restart and the like. The fraction of ~~recover~~ recovery failures value may be known as f-cfo-fail.

Please replace the paragraph [0039] with the following amended paragraph:

\\\SO - 80168/0108 - 170000 v1

5

PAGE 6/18 * RCVD AT 11/10/2004 7:21:10 PM [Eastern Standard Time] * SVR:USPTO-EFXRF-1/3 * DNIS:8729306 * CSID: * DURATION (mm-ss):05-22

Serial No. 09/850,183
Reply to Office Action of September 9, 2004

[0039]   An analogous approach to that used for application failures may be used to model operating system failures. An operating system affects a large number of operations, and the operating systems on the various nodes cooperate. Slightly different failure classes may be assigned to an operating system failure. The first class may be problems requiring a single node reboot. The second class may be problems requiring a reboot of the entire cluster. The third class may be problems requiring service.

Please replace the paragraph [0041] with the following amended paragraph:

[0041]   Software component node reboot state 210 may be characterized by a reboot rate known as mu-node-reboot. The reboot rate may reflect that time is takes to reboot the affected node, and bring all the node components back on-line. Preferably, mu-node-reboot may be from about .05 Hz to about .2 Hz. Software component node reboot state 210 also includes a value for the fraction of reboot failures. This value would serve to model reboots that are not effective in resolving the application failure, such as damage not confined to one node, miscellaneous failures to reboot and the like. The fraction of reboot failure value may be known as f-nr-fail.

Please replace the paragraph [0042] with the following amended paragraph:

[0042]   Software component cluster reboot state 212 may reflect those errors that are not resolved by any of the above-disclosed models[[,]] and result in an entire network cluster reboot. If a node reboot is ineffective, a cluster reboot may be performed. A node reboot has not been effective in resolving the error. A cluster reboot involves a shutdown and reboot of all computers in the cluster. An error or failure impacting multiple nodes may be remedied by the cluster reboot. The rate of cluster reboots may be characterized by the time it takes to reboot the cluster network[[,]] and may be known as mu-cluster-reboot. Software component cluster reboot state 212 and software component node reboot state 210 may be characterized by platform-specific parameters. Platform-specific parameters indicate that the errors are not confined to a software application[[,]] and measures indicate that actions outside of restarting the application need to be taken.

Please replace the paragraph [0048] with the following amended paragraph:

[0048]   According to an embodiment, the time parameters determined above

\\\SO - 60168/0106 - 170900 v1

6

PAGE 7/18 * RCVD AT 11/10/2004 7:21:10 PM [Eastern Standard Time] * SVR:USPTO-EFXRF-1/3 * DNIS:8729306 * CSID: * DURATION (mm-ss):05-22

Serial No. 09/850,183
Reply to Office Action of September 9, 2004

may be combined with the time-sw-ccr parameters of the application components in order to generate the node and cluster reboot rates. By incorporating application restart times into node restart times, a platform specific summation formula is determined that accounts for the plausible degrees of parallelism/serialization within the network.

Please replace the paragraph [0049] with the following amended paragraph:

[0049]   Because [[of]] the fail-over of whole nodes may occur rather than individual software components, an aggregate node fail-over time is computed. The aggregate node fail-over time may be a platform specific summation of the component fail-over times for all the software components on a node. As noted above, these failure rates and recovery rates may be used to determine parameters for a single software failure model for a particular platform.

Please replace the paragraph [0058] with the following amended paragraph:

[0058]   Fig. 5 depicts a flowchart for constructing a software availability model in accordance with an embodiment of the present invention. Step 500 executes by determining whether a component to be modeled is a software application or part of the operating system. If [[no]] not part of the operating system, then step 502 executes by estimating/measuring the failure rate, repair time and efficacy value for the warm reset state. Step 504 executes by estimating/measuring the failure rate, repair time and efficacy value for the warm restart state. Step 506 executes by estimating/measuring the failure rate, repair time and efficacy value for the cold restart state. Step 508 executes by estimating/measuring the failure rate, repair time and efficacy value for the fail-over state.

Please replace the paragraph [0060] with the following amended paragraph:

[0060]   If step 500 [[is yes]] indicates the component to be modeled is part of the operating system, then step 516 executes by estimating/measuring the node reboot failure rate, repair time and efficacy value. Step 518 executes by estimating/measuring the cluster restart failure rate and repair time. Step 520 executes by computing a node reboot repair rate from a platform-specific sum of the operating system times and software component cold restart times.

7